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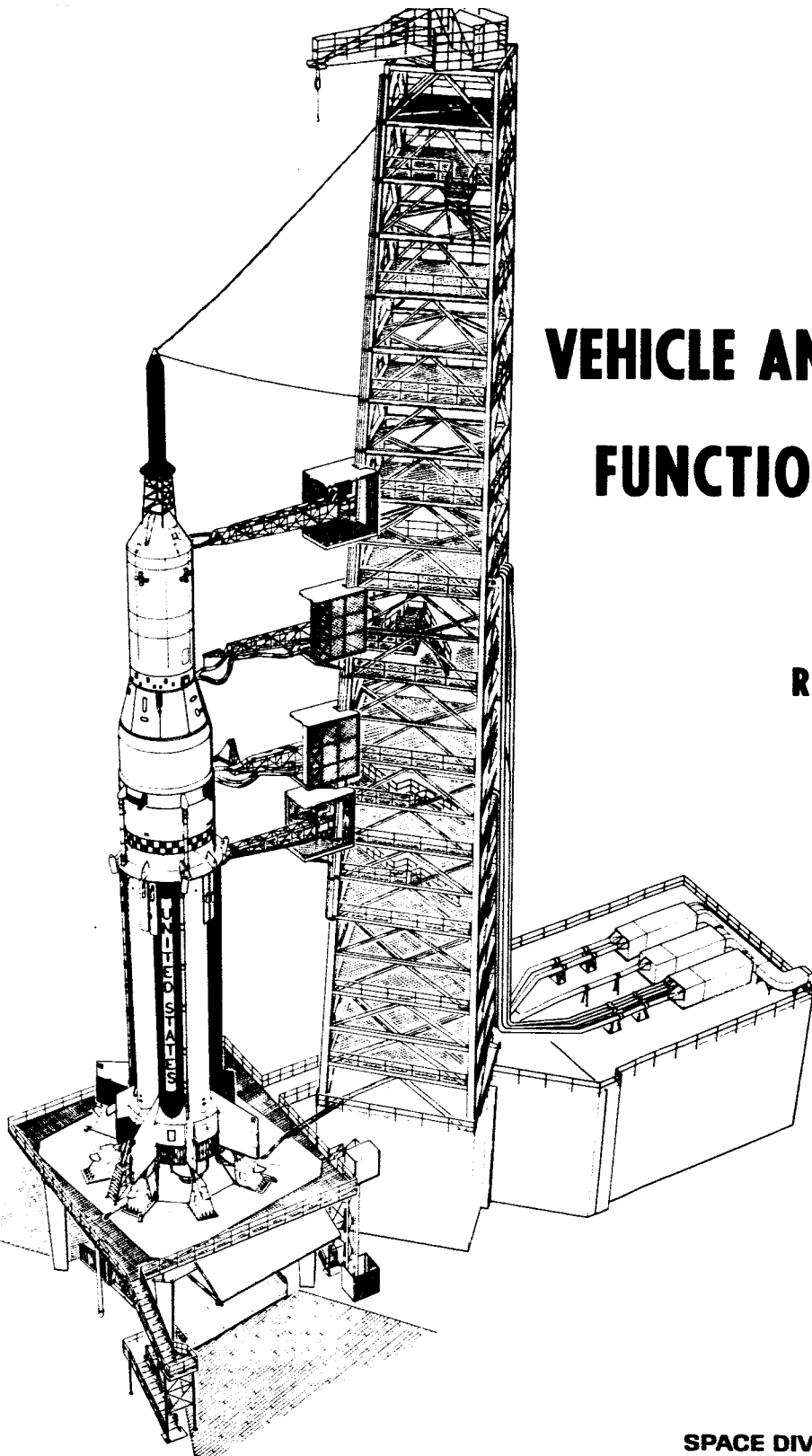
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RP-1 FUEL SYSTEM

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SPACE DIVISION



CHRYSLER
CORPORATION

HUNTSVILLE OPERATIONS

**HEC-D042
VOLUME I**

**SA-9
VEHICLE AND LAUNCH COMPLEX
FUNCTIONAL DESCRIPTION**

RP-1 FUEL SYSTEM

APRIL 1964

ENGINEERING COMMUNICATIONS DEPARTMENT

SPACE DIVISION



**CHRYSLER
CORPORATION**

HUNTSVILLE OPERATIONS

FOREWORD

This volume has been prepared for the Functional Integration Section, Systems Integration and Operations Branch, Vehicle Systems Division, Propulsion and Vehicle Engineering Laboratory, by the Engineering Communications Department, Chrysler Corporation Space Division, under contract number NAS8-4016.

The following series, of which this volume is a part, functionally describes the mechanical and electromechanical systems of Saturn I, SA-9 space vehicle and Launch Complex 37:

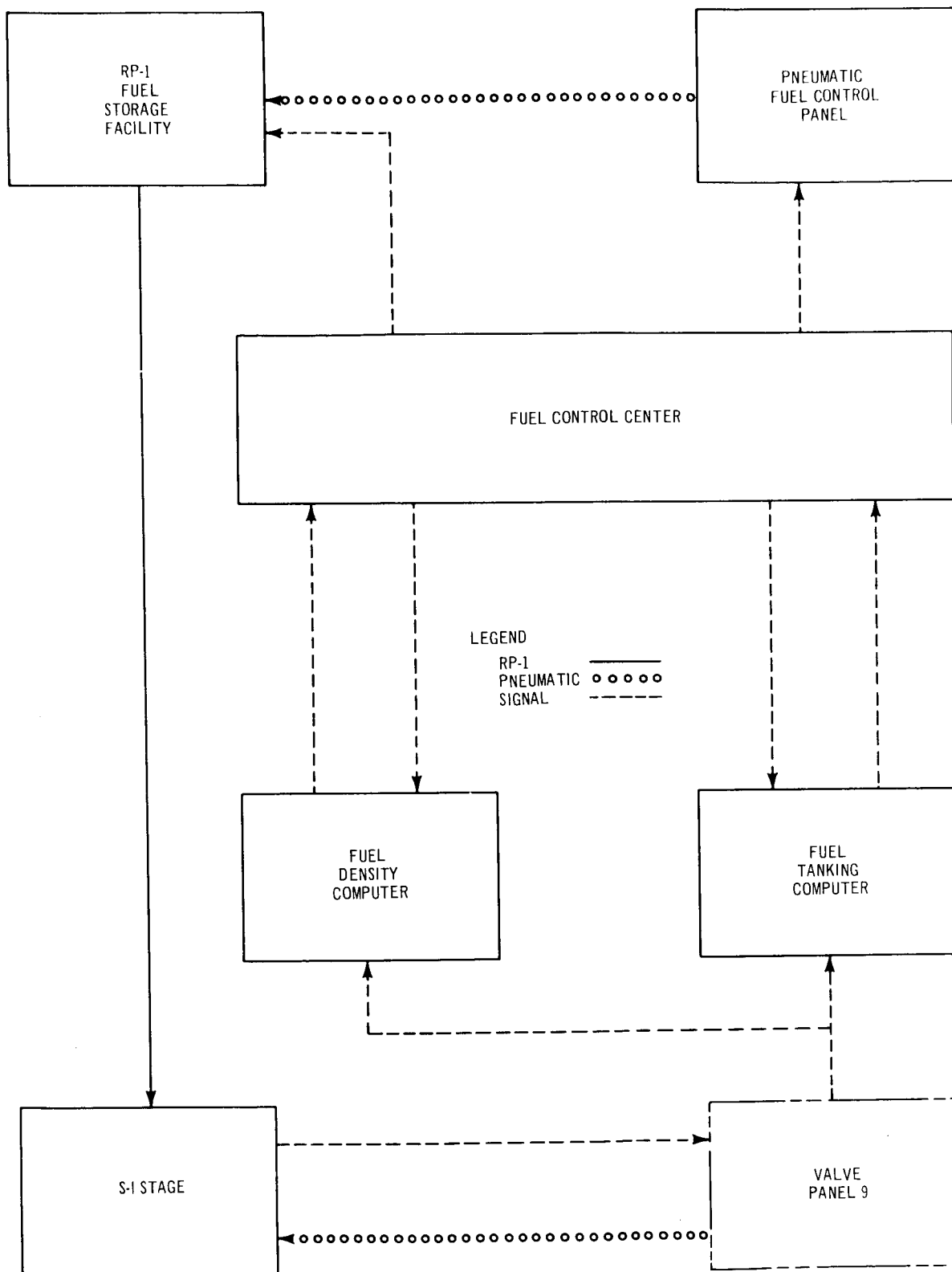
Volume I.	RP-1 Fuel System
Volume II.	LOX System
Volume III.	LH ₂ System
Volume IV.	Nitrogen and Helium Storage Facility
Volume V.	Pneumatic Distribution System
Volume VI.	Environmental Control System
Volume VII.	Launch Pad Accessories
Volume VIII.	H-1 Engine and Hydraulic System
Volume IX.	RL10A-3 Engine and Hydraulic System
Volume X.	Separation and Flight Termination Systems
Volume XI.	Supplement: Legend and Composite Schematic

Each volume contains mechanical schematics and a list of applicable finding numbers.

Volume I describes those components that are active during countdown, launch, and flight: it specifically excludes maintenance and checkout procedures. Only information available by March 10, 1964, has been included.

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C-H 7524

FIGURE 1. RP-1 FUEL SYSTEM

1. RP-1 FUEL SYSTEM DESCRIPTION

The RP-1 fuel system (figure 1) consists of ground-based equipment that supplies fuel to the first stage of the Saturn vehicle, and vehicle equipment that stores and supplies fuel to the S-I stage propulsion system. (The ground-based equipment of the fuel system consists of a fuel storage facility, a pneumatic fuel control console, a fuel control center, a fuel tanking computer, and a fuel density computer.) The storage facility contains the necessary equipment to store, filter, and transfer the RP-1 fuel to the vehicle, and to drain the vehicle if the launching should be aborted. The pneumatic fuel control console regulates, supplies, and controls the pneumatic pressure that actuates storage facility components. The fuel control center monitors and controls the various tanking operations associated with the transfer of RP-1 fuel to the vehicle. The fuel tanking and density computers control the filling of the vehicle fuel containers to ensure the desired RP-1 to LOX weight ratio. Fuel from the ground system enters the vehicle through a fuel filling mast, which is retracted prior to liftoff (described in Volume VII).

The vehicle fuel equipment consists of four fuel containers; a pressurization manifold, a fuel transfer assembly, and various control devices and lines for filling, draining, venting, fuel leveling, and supplying fuel to the H-1 engines. The four fuel containers are (alternately arranged with four LOX containers in a circular pattern around a larger, center LOX container). The pressurization manifold, interconnecting the upper portions of the fuel containers, maintains an equal ullage pressure during flight. The lower interconnecting manifold between the fuel container sumps maintains a nearly equal fuel level in the containers.

1.1. Fuel Control Center

The basic fuel controls, located in the launch control center, consist of equipment for initiating, monitoring, controlling, and correcting fuel transfer operations.

1.1.1. RP-1 Control Panel. The RP-1 control panel contains various switches used to initiate the commands for sequential progression of the fill, adjust level, replenish, and drain operations. The panel also contains indicator lamps that provide monitoring of the various operations.

The 'power' switch supplies electrical power to the control panel components. The 'function selector' switch has four positions: 'operate,' 'simulate,' 'manual,' and 'off.' 'Operate' provides automatic sequential operation of the various RP-1 fuel system operations. 'Simulate' is the same as 'operate,' except that pump motors do not operate and there is no fuel flow. 'Manual' transfers control to the RP-1 components panel for individual component operation.

The 'fill' pushbutton initiates the fuel fill operation. The operation consists of a fast fill sequence, which underfills the S-I containers (to 98% of the programmed mass) at a flow rate of 2000 gpm; a slow fill sequence, which overfills the S-I containers (to approximately 102% of the programmed mass) at a reduced flow rate of 200 gpm; and a transfer line drain sequence, which drains the fuel from the transfer line after the slow fill sequence has been completed.

The 'slow-fill' pushbutton initiates the slow fill sequence if it becomes necessary to fill the S-I fuel containers at a reduced flow rate.

The 'adjust-level' drain pushbutton switch initiates the draining of excess fuel from the S-I containers and transfers control of the adjust level operation to a three-way toggle switch with 'line inert,' 'reset' and 'off' positions. The 'line inert' position initiates draining of the fuel filling mast and transfer line after excess fuel in the S-I containers has been removed. The 'reset' position reverts the adjust level drain sequence to standby, permitting the sequence to be repeated as necessary.

The 'mast purge' toggle switch is positioned manually to initiate fuel fill mast and transfer line purge during the transfer line drain portion of the adjust level operation.

The 'replenish' pushbutton switch initiates the automatic replenish operation, which consists of a transfer line fill sequence, a replenish sequence to supply additional fuel to the S-I containers, and a transfer line drain sequence after the S-I containers have been replenished.

The 'drain' pushbutton initiates the automatic drain operations, which empty the S-I fuel containers.

The 'fuel bubbling' switch has three positions: 'manual,' 'automatic,' and 'off.' The 'manual' position provides fuel bubbling system checkout. The 'automatic' position allows a signal from open Fuel Vent Valves B106 to initiate fuel bubbling before LOX is tanked and again after the adjust level drain operation.

1.1.2. Fuel Computer Panels. The fuel density and fuel tanking computer panels provide test and power switches for checkout and control of the density computer and tanking computer. Associated fuel density and quantity digital indicator panels allow monitoring of tanking operations.

1.1.3. RP-1 Components Panel. The components panel contains switches for individual operation of storage facility components when the function selector switch on the RP-1 control panel is in 'manual' position. Indicating lights on the components panel provide indications of component condition.

1.2. RP-1 Fuel Tanking and Density Computers

The primary propellant loading objective is to obtain a constant predetermined total weight of LOX and fuel (RP-1), with the ratio of LOX weight to fuel weight varying as a function of the fuel density to permit theoretically simultaneous LOX and fuel depletion at S-I stage burnout. The accurate control of the propellant liquid levels is maintained semiautomatically from the propellant control panels located in the launch control center. These panels are electrically integrated with the LOX, fuel, and fuel density computers.

1.2.1. Fuel Density Computer. The fuel density computer system consists of three primary units: Fuel Density Computer A507 located in the automatic ground control station below the umbilical tower, a fuel density computer panel, and a digital indicator (the latter two items being located in the launch control center propellant loading rack assembly No. 2).

The fuel density computer incorporates a differential pressure transducer that senses a differential height of fuel in Container F-4. This differential height of fuel is determined by pressure from a probe extending to the bottom of the container and from one of four upper probes. Because the probe must be covered by fuel for the density computer to operate properly, the particular vehicle mission determines which upper probe is selected. A specific gravity of 0.810 is usually assumed to determine a nominal differential pressure (fuel density programmed pressure) between the selected probes. This pressure is programmed into the computer before delivery to the launch site and is preset on the fuel density computer panel. After the S-I stage is filled, any shift in the measured differential pressure indicates a shift in the density by a proportional amount, because the differential probe height remains constant.

The fuel density computer panel provides a direct indication of 'fuel density differential pressure' as programmed into the density computer.

The fuel density digital indicator panel displays fuel density in Container F-4 as a percentage of a nominal density preprogrammed into Density Computer A507. When the containers are filled, the actual fuel density is displayed as a percentage of the nominal density, based on the set pressure differential appearing on the fuel density computer panel. From this percentage shift in density and from the propellant loading tables, density corrections may be applied to the tanking operations. The proper correction is dialed in at the fuel tanking computer panel and excess fuel is drained during the adjust level drain sequence. (Some fuel is always drained after the density correction is made, because the fuel tanks are initially overfilled.)

1.2.2. Fuel Tanking Computer. The fuel tanking computer system consists of three primary units: Fuel Tanking Computer A506 located in the automatic ground control station below the umbilical tower, fuel tanking computer panel, and a digital indicator. (The latter two items are in the launch propellant loading rack assembly No. 2.)

Fuel Tanking Computer A506 (figure 3) incorporates a transducer which senses the differential pressure in Fuel Container F-4 during the filling operation. The differential pressure is measured between a probe located in the top of the container and one near the bottom of the container. A single lower container probe serves both density and tanking computers through a tee connection near normally closed Solenoid Valve A5066. Before delivery to the launch site, the tanking computer is preprogrammed for the differential pressure head of fuel, based on the height between the probes and the same nominal specific gravity of approximately 0.810 selected for the density computer. This programmed pressure is preset on the fuel tanking computer panel in addition to a + 0.465-psig fuel differential pressure correction (approximate value) to provide initial overfilling of the fuel containers. During tanking operations, the digital indicator panel indicates a value as a percent of the algebraic sum of the set value and the correction value. Before tanking operations, 98% of this combined value is programmed into the computer circuitry to enable initiation of the slow fill sequence. The full value (100%) is also programmed into the computer circuitry to terminate the filling operation. Computer command signals are monitored from the fuel tanking computer panel and are interlocked with the RP-1 control panel to position various solenoid-operated components in the fuel system. After the containers are overfilled, a new pressure correction, based on the density indication appearing on the density digital indicator panel and the propellant loading tables, is dialed into the fuel computer panel. The tanking digital indicator panel then indicates how much fuel has been tanked as a percentage of this new differential pressure (original set pressure plus new pressure correction). The percentage indication drops to 100% as the adjust level operation drains excess fuel. At 101% of desired differential pressure, the computer sends a signal to Pneumatic Controller A559, which supplies 15-psig GN₂ to Adjust Level Regulator A522. The pressure from the pneumatic controller is reduced to 3 psig at 100% full by a signal from the computer, at which point Adjust Level Regulator A522 is completely closed and the draining operation is stopped.

The fuel tanking computer panel has two manually set digital readouts. One scale, marked 'fuel differential pressure (psi)' is preset for a nominal value of fuel tank differential pressure; the other scale, marked 'pressure correction (psi),' is adjustable ± 0.465 psi for differential pressure corrections based on fuel density deviations from a nominal preselected value as indicated by the fuel density digital indicator. A telephone type dial and a polarity (add-subtract) selector switch are used for making differential pressure corrections. After the S-I stage containers are overfilled, a new pressure correction, based on the density indication appearing on the density digital indication panel and the propellant loading tables, is dialed into the fuel tanking computer panel. Subsequent adjust level drain operations drain excess fuel.

The fuel quantity digital indicator panel displays fuel quantity in Container F-4 as a percentage of the total programmed differential pressure on the fuel tanking computer panel.

1.3. RP-1 Storage Facility.

The RP-1 storage facility consists of a storage tank, pneumatic fuel control console, a filtration system, and a transfer system. The storage facility equipment transfers fuel to the vehicle and drains the vehicle if necessary.

The storage tank has a 57,000-gallon capacity. Pressure relief and vacuum relief valves are installed on the tank to prevent overpressure or vacuum conditions inside the tank. A liquid level gage and a temperature gage provide local monitoring of the fuel in the storage tanks.

The pneumatic fuel control console, located at the storage facility, contains manual valves, pressure gages, solenoid valves, orifices, a filter, a pressure switch, a regulator, and a relief valve. The control console input pressure is reduced and supplied to the solenoid valves that control the pneumatic valves located in the storage facility.

The filtration system removes water and other foreign matter from the fuel during storage tank filling and refiltering operations. The system consists of a pump and motor, and a filter separator containing gages, manual valves, automatic flow control valves, relief devices, and replaceable filter cartridges.

During transfer operations, the storage facility equipment transfers fuel to the vehicle and drains fuel from the transfer line upon termination of the fill sequence. An adjust level sequence is initiated after termination of transfer line drain, to drain excess fuel from the vehicle back into the storage facility. If fuel requirements are increased after the adjust level has been completed, an automatic replenish sequence can be initiated from the Launch Control Center (LCC).

1.4. S-I Stage

The vehicle RP-1 fuel system consists of 70-inch diameter Fuel Containers F-1, F-2, F-3, and F-4; a pressurization manifold that interconnects the upper portion of the four containers; two vent valves; two relief valves; a lower interconnecting manifold between the fuel container sumps; eight fuel suction lines that supply fuel from the containers to the engines; eight pre valves, one in each suction line; a fuel fill and drain valve; and various control devices for S-I stage operations. Each fuel container supplies fuel to one inboard engine and one outboard engine. The pre valves, located near the top of each fuel suction line, remain open and are closed only in case of an emergency or engine cutoff. The pre valves are operated by an onboard pressure control system. The fuel vent valves are operated by pressure from valve panel 9, and the fuel fill and drain valve is operated by pressure from the launcher manifold. Fuel Container F-4 contains the fuel tanking and density computer sensing lines that are used to control fill operation. The fuel containers are pressurized initially and during flight with GN₂ from an onboard pressure system.

2. RP-1 STORAGE FACILITY OPERATION

Figure 2 page 33, representing complex 37 RP-1 fuel system, and figure 3 page 35, representing the vehicle RP-1 fuel system, should be used, in conjunction with the text, to follow the various flow routes of the fuel system operations.

2.1. Storage Tank Fill Operation

Fuel service trailers deliver the RP-1 fuel to the storage facility and transfer the fuel through flexible lines into the storage facility. The fuel is pumped through a filter-separator unit before it enters the storage tank. The following valves are open for storage tank fill operation: A526, A527, A611, A612, A610, A615, and A524.

Fuel from the service trailers flows through Adapters A568 and A569, Check Valve A536, Manual Valve A526, and past 60-psig Relief Valve A545 to Filter-Separator Pump A503. The pump, driven by Motor A505, delivers 600 gpm of RP-1 fuel at 31.5 psig past Temperature Switch A579 and through Manual Valve A527 to Filter-Separator A509. Fuel passes through the filter-separator element and fills the tank of the filter-separator. Automatic Air Release Valve A539 relieves air from the tank as it is displaced by the rising fuel level. When the fuel level rises into the automatic air release valve, the valve closes and pressure begins to build up in the filter-separator tank. Relief Valve A547 provides overpressure protection for the filter-separator. Water and foreign matter, removed from the fuel by the filter-separator element, settle to the bottom of the filter-separator tank and are drained by the operation of Float Operated Control Valve A609, Fuel Discharge Regulator A538, and Water Drain Regulator A548. The float operated control valve contains a multi-ported distributor and rotary disc. The float, submersed in fuel and riding on the water level in the filter-separator, positions the disc to align the disc ports with the distributor ports. The fluid that flows through the ports produces the actuating pressure that positions Fuel Discharge Regulator A538 and Water Drain Regulator A548. If little or no water is present, Float Control Valve A609 fully opens Fuel Discharge Regulator A538. Fuel from the filter-separator flows through Fuel Discharge Regulator A538, past Relief Valve A571, through Check Valve A535, and Manual Valve A524 into Storage Tank A501. As the water level in Filter-Separator A509 rises, the float control valve starts to reposition its pressure ports, causing Fuel Discharge Regulator A538 to start closing. When sufficient water has been filtered from the fuel, the float control valve fully closes Fuel Discharge Regulator A538 and opens Water Drain Regulator A548. The pump pressure then forces the water out of the tank through the water drain valve. When the water level recedes to a safe level, the float control valve repositions and closes Water Drain Regulator A548, and reopens Fuel Discharge Regulator A538, allowing the fuel flow to continue to the storage tank. The opening and closing cycle of Fuel Discharge Regulator A538 and Water Drain Regulator A548 continues throughout the storage tank fill operation as water is removed from the fuel.

Differential Pressure Gage A565 monitors the filter in Filter-Separator A509. A differential pressure of 8.5 psig indicates the need for a filter change. Sight Gage A608 provides a visual indication of water and fuel levels within the filter-separator. If the automatic water drain components fail to operate, the water can be drained manually through Manual Drain Valve A549, or the filter-separator can be bypassed by closing Manual Valve A527 and opening Bypass Valve A529. Overpressure protection for the fill line between Filter-Separator A509 and Storage Tank A501 is provided by 60-psig Relief Valves A571 and A544, which relieve into a return line to the storage tank ullage. If the RP-1 temperature reaches an unsafe level during filling operation (approximately 110°F), Temperature Switch A579 will stop Pump Motor A505 to prevent a fire hazard. Temperature Gage A561 and Liquid Level Gage A560 indicate the storage tank RP-1 temperature and level. Vent and Vacuum Valve A537 relieves excess storage tank pressure at 0.25 psig and relieves storage tank vacuum at -0.06 psig. Relief Valve A540 relieves storage tank pressure at 2.5 psig if the vent and vacuum valve cannot sufficiently vent the tank.

When the fuel reaches the desired level in the storage tank, Pump A503 is stopped. After Manual Valve A526 has been closed, the residual fuel in the flexible lines is pumped back into the service trailers. Vacuum Breaker A576 is opened to relieve the vacuum in the flexible lines caused by draining residual fuel back into the service trailer. The vacuum breaker is closed after the flexible lines have been disconnected.

Alternate methods may be used to fill the storage tank if the method described in 2.1. is rendered inoperative. The fuel service trailer, connected to Coupling-Half A570 by a flexible line, pumps fuel through Coupling-Half A570, past Vacuum Breaker A577, through Manual Valve A528, Manual Valve A527, and Filter-Separator A509; or, if the filter-separator is inoperative, through Manual Valve A529. Fuel then flows through Check Valve A535, past Relief Valve A544, and through Manual Valve A524 into Storage Tank A501.

Fuel can be transferred directly into the storage tank through a quick-opening fill port in the cover over Manhole A554.

2.2. RP-1 Fuel Refiltering

After the RP-1 storage tank has been filled, the refiltering operation is performed daily to prevent excessive amounts of water and foreign matter from accumulating in the fuel. Approximately one week before the fuel is to be loaded into the vehicle, the refiltering operation is begun and fuel circulates through the filter-separator unit continuously until loading time to assure the purity of the fuel.

The manual valves open for the refiltering operation are: A525, A527, A611, A612, A610, A615, and A524. Fuel flows by gravity from Storage Tank A501 through Manual Valve A525 and past 60-psig Relief Valve A545 and Manual Valve A526 to Filter Separator Pump A503. (The fuel flow continues through the path described in the second paragraph of 2.1.)

When the fuel has been filtered sufficiently the pump and motor are stopped and Manual Valves A524 and A525 are closed. The filter-separator unit and the inlet line are drained when necessary through Manual Drain Valves A613, A614, and A615. Manual Drain Valve A533 drains residual fuel from the storage tank ullage return line.

To ensure that the fuel meets the prescribed requirements, samples are taken from the storage tank and analyzed. Quick-Opening Cover A541 provides access to Sampling Well A556 in Storage Tank A501. A sampling bob is lowered into the well to obtain fuel samples.

3. TRANSFER OPERATIONS

Transfer operations include all operations necessary to fill the S-I stage fuel containers to the proper level for a given flight mission. There are four operations involved: fill, fuel bubbling, adjust level, and replenish. The operations can be performed either manually or automatically from the fuel control center. The pneumatic fuel control console supplies and controls the actuating pressures to the pneumatic valves in the storage facility.

3.1. Pneumatic Fuel Control Console

The high pressure gas storage battery supplies 3500-psig GN₂ to the pneumatic fuel control console. The 3500-psig GN₂ is reduced to 750 psig and supplied to five normally open and five normally closed solenoid valves that control the storage facility pneumatic valves. The following manual valves are open for the console operation: A2890, A2852, and A2858 (figure 2).

GN₂ flows through Manual Valve A2890, past Pressure Switch A2883, and enters the pneumatic fuel control console through 10-micron Filter A2860. GN₂ from the filter flows past Orifice A2861, which provides an inert atmosphere by bleeding GN₂ into the console; Manual Vent Valve A2850; Pressure Gage A2851; through Manual Valve A2852; and past Manual Vent Valve A2853 to Pressure Regulator A2854. The manually adjusted regulator reduces 3500 psig to 750 psig. GN₂ supplied at 750 psig by Pressure Regulator A2854 flows past Relief Valve A2855, Pressure Gage A2856, Manual Vent Valve A2857; through Manual Valve A2858, past Pressure Switch A2882, which is protected from pressure surges by Snubber A2862, and Manual Vent Valve A2859 to the control solenoid valves. The solenoid valves are operated from the fuel-control center and control the 750-psig GN₂ opening and closing pressure to the storage facility pneumatic valves. The following list contains the pneumatic valves and the solenoid valves that open and close them.

Pneumatic Valves	Solenoid Valves	
	Opening Control	Closing Control
A518	A2870	A2865
A520	A2872	A2867
A517	A2869	A2864
A521	A2871	A2866
A516	A2868	A2863

Manual Metering Valve A2881 prevents hammering in Slow Fill Valve A521 by slowly venting its opening actuator when Solenoid Valve A2871 is de-energized. Orifices A2897, A2896, A2895, and A2894 prevent Pneumatic Valves A518, A520, A517, and A516 from slamming closed when their respective opening control solenoid valves have been de-energized. Pressure Switches A2883 and A2882 indicate to the fuel control center that the required operating pressures are available.

3.2. Fill

The S-I stage fuel containers are filled with RP-1 at T -2 days. This involves a manual and an automatic operation. The manual operation fills the vehicle to 15% full to allow a leak check of the RP-1 fuel system. After the system has been thoroughly inspected, an automatic fill operation consisting of a fast fill, a slow fill, and a line drain sequence is initiated. The fast fill sequence fills the vehicle fuel containers at 2000 gpm to 98% of the fuel mass programmed (as the corresponding pressure) into Fuel Tanking Computer A506. The slow fill sequence fills the fuel containers to 100% at a reduced flowrate of 200 gpm. Because the fuel flowrate has been reduced, Fuel Tanking Computer A506 can stop the filling sequence when the exact programmed amount of fuel has been transferred. An excess amount of fuel is initially programmed and transferred to the vehicle for a given amount of LOX. The adjust level sequence (described in 3.4.) drains the excess fuel from the vehicle fuel containers after fuel density corrections have been programmed into the fuel tanking computer.

3.2.1. Manual Fill. The Manual Valves open for the fill operation are: A523, A524, A572, A573, A574, and A590 (figure 2); and B108 and B110 (figure 3).

The fuel density computer panel indicates the density differential pressure that has been programmed into Fuel Density Computer A507. Using a nominal specific gravity of 0.810, the programmed pressure is based on the pressure head between two probes of known differential height in Fuel Container F-4.

The fuel tanking computer panel indicates the nominal programmed fuel differential pressure specified in the propellant loading tables and a pressure correction (usually +0.465 psig) that will ensure the loading of excess fuel.

The function selector switch on the RP-1 control panel is in 'manual' position, transferring component control to the components panel. The components are actuated by individual switches to fill the vehicle containers to 15% for the leak check. Indicating lights on the panel front indicate component condition. With the corresponding switches in the 'on' position, Slow Fill Valve A521 and Discharge Valve A516 are opened by solenoid valves in the pneumatic fuel control console (refer to 3.1. par 2.); Booster Line Valve A519 is opened by Solenoid Valve A2138 in valve panel 5; Fuel Fill and Drain Valve B111 is opened by Solenoid Valve A5617 on the launcher manifold; and S-I stage Fuel Vent Valves B106 are opened by Solenoid Valve A5023 in valve panel 9. After all valves are open, the fuel transfer pump motor switch is placed in the 'on' position to actuate Pump Motor A504 (figure 2).

Fuel flows by gravity from Storage Tank A501 through Manual Valve A523, past Pressure Gage A572 and Relief Valve A546, to Fuel Transfer Pump A502, which is driven by Pump Motor A504. The pump discharges RP-1 at 200 gpm and at approximately 175 psig. Fuel from the pump flows past Temperature Switch A578 and Pressure Gage A563, through Strainer A511, and past Pressure Switch A566 and Pressure Gage A564. The transfer line branches and fuel flows through Slow Fill Valve A521, Orifice A551, past Shock Arrestor A515, and through Discharge Valve A516. Fuel flows past Relief Valve A543, Liquid Level Sensor A552, through Manual Valve A590, past Liquid Level Sensor A553 and Relief Valve A593, and through Strainer A575 to Air Eliminator A557 and Booster Line Valve A519. Air Eliminator A557 releases air from the fuel and the transfer line to atmosphere through Air Vent A558. Fuel from the booster line valve flows through Strainer A512, past Vacuum Breaker A4505 and Check Valve A4501, and enters the S-I stage through Couplings A4500 and B112 (figure 3). Fuel flows through Fuel Fill and Drain Valve B111 and enters the sump of Fuel Container F-1. Fuel flows from Fuel Container F-1 through the lower interconnecting manifold and fills Containers F-2, F-3, and F-4. Fuel Vent Valves B106 vent air from the containers as it is displaced by the rising fuel level.

During the operation, Pressure Gages A562 and A563 indicate the transfer pump inlet and outlet pressures. Temperature Switch A578 will stop the pump motor if the RP-1 temperature reaches an unsafe level (approximately 110°F). Pressure Gages A563 and A564 indicate the pressure drop across Strainer A511. Pressure Switch A566 actuates at 39 ± 4 psig rising pressure, indicating at the fuel control center that the fuel transfer pump is operating. Shock Arrestor A515 protects the transfer system components by dampening pressure surges. Relief Valve A593 provides overpressure protection for the transfer line section between Manual Valve A590 and Booster Line Valve A519. Relief Valve A602 protects Air Eliminator A557 from pressure surges by relieving at a differential pressure of 5 psi between the air eliminator and the downstream portion of the transfer line. Air Vent A558 contains baffles that trap fuel from the air venting to atmosphere from the transfer line. The air eliminator does not close until the transfer line is filled with fuel.

When the fuel level in the containers reaches 15% as indicated on the fuel tanking digital indicator panel, the manual operation is terminated by placing the switches on the components panel in the 'off' positions. After the leak check has been completed, and the system condition has been found to be acceptable, the automatic fill sequence is initiated.

3.2.2. Automatic Fill. With function selector switch on the RP-1 control panel in the 'operate' position, depressing the fill pushbutton on the panel initiates the fill operation. Fast Fill Valve A517, Slow Fill Valve A521, Discharge Valve A516, Booster Line Valve A519, Fuel Fill and Drain Valve B111, and Fuel Vent Valves B106 open. Pump Motor A504 starts and drives Fuel Transfer Pump A502. Fuel flows at 2000 gpm through the same path described for manual fill and also through Fast Fill Valve A517 combining with the fuel flow through Slow Fill Valve A521.

Fuel Tanking Computer A506 and Fuel Density Computer A507 monitor the filling operation, and provide tanking data to the fuel control center. When the containers are filled to 98%, the fuel tanking computer stops the fast fill sequence and initiates the slow fill sequence. Fast Fill Valve A517 closes. Fuel continues to flow into the fuel containers, but at the reduced flowrate of 200 gpm effected by Orifice A551. When Fuel Tanking Computer A506 senses 100% fuel load in the containers, it stops the slow fill sequence and initiates transfer line drain by closing Slow Fill Valve A521, Booster Line Valve A519, and Fuel Fill and Drain Valve B111, and by opening Circulate and Drain Valve A518 and Line Drain Valve A520. If the fuel tanking computer fails to stop the fill sequence at 100%, Overfill Pressure Switch B109 (figure 3) will stop the sequence and initiate transfer line drain.

3.2.3. Transfer Line Drain. The action of the transfer pump and jet eductor drains fuel from the transfer line into the storage tank. Fuel from Storage Tank A501 flows through Manual Valve A523 to Fuel Transfer Pump A502 that pumps the fuel through Strainer A511, Line Drain Valve A520, and Jet Eductor A514. Fuel flowing through Jet Eductor A514 produces a partial vacuum causing fuel in the transfer line to flow through Discharge Valve A516 and past Relief Valve A542 into the jet eductor. Fuel flow from the jet eductor continues through Circulate and Drain Valve A518 and Manual Valve A524 into the storage tank. Air Eliminator A557 and Air Vent A558 admit air and fuel that was trapped by the air vent baffles into the transfer line as the fuel flows back into the storage tank. A 100-mesh filter in the air vent prevents contaminants from entering the transfer line. As the transfer line drain sequence progresses, Liquid Level Sensor A552 detects the absence of fuel in the transfer line and initiates a three minute timer.

At the end of the three minutes, the timer stops Fuel Transfer Pump A502 and Motor A504 and closes Discharge Valve A516, Line Drain Valve A520, and Circulate and Drain Valve A518. The automatic fuel operations are complete at termination of transfer line drain sequence.

Fuel Density Computer A507 senses differential pressure between the two preselected probes and compares this pressure to the programmed differential pressure. The percentage change in density, proportional to the percentage change in pressure, is dialed into the fuel tanking computer panel as a correction. This correction is always smaller than the initial correction (0.465 psig) to allow draining the containers to the desired level without reactivating the filling equipment.

Once a new pressure correction is dialed into the fuel tanking computer panel, the new pressure is considered 100%, leaving the original total differential pressure slightly higher. The digital indicator then reads more than 100% tanked (approximately 102.0%), and shows what percentage of fuel must be drained during the adjust level drain sequence.

After the fill operation has been completed, fuel remains in a section of transfer line and the fuel mast between Booster Line Valve A519 and Fuel Fill and Drain Valve B111. Depending on the length of time until the adjust level drain operation is initiated, thermal expansion of the fuel may cause

excess pressure, which will be relieved by Relief Valve A616, through Air Eliminator A557, and into the upstream section of the transfer line.

3.3. Fuel Bubbling Operation

Engine start characteristics are improved by reducing temperature stratification in the RP-1 fuel suction lines before vehicle launch. GN₂ bubbling of the RP-1 in each suction line begins at approximately T -6 hours, just before the LOX containers are filled to 15% for leak check. The RP-1 bubbling is terminated just before the final fuel tanking corrections are made by the adjust level drain operation. After the adjust level drain operation has been completed, RP-1 bubbling resumes and continues until pressurization of the fuel containers begins.

GN₂ from valve panel 10 flows through Solenoid Valve A5194, over short cable mast No. 2, and enters the S-I stage through Couplings A6505 and B370 (figure 3). Twenty-Micron Filter B373 removes contaminants from the GN₂ as it enters the vehicle fuel bubbling manifold. Individual lines supply GN₂ to each engine RP-1 suction line. Orifices B372 mounted in each supply line reduce the supply pressure and protect the suction lines from overpressure surges. Check Valves B371 mounted downstream from each orifice prevent reverse flow of RP-1 into the bubbling manifold in the absence of GN₂ pressure. The GN₂ passes through open Prevalves B103 and enters Fuel Containers F-1, F-2, F-3, and F-4 before being vented out of the ullage portion of the containers through Fuel Vent Valves B106. Fuel bubbling continues until the beginning of the automatic countdown sequence at T -150 seconds. At this time Vent Valves B106 close and pressurization of the fuel containers begins.

3.4. Adjust Level Drain

The adjust level drain operation removes excess fuel from the vehicle fuel containers after the LOX fill operation has been completed. The adjust level drain operation is conducted semiautomatically at approximately T -35 minutes and includes a transfer line drain sequence and a mast purge sequence.

Manual Valves A523, A524, and A590 and Fuel Vent Valves B106 are open. The RP-1 control panel and the computer panel power switches are in the 'power' positions, the function selector switch on the RP-1 control panel is in the 'operate' position, and the line inert-reset switch is in the 'line-inert' position. The fuel tanking digital indicator panel indicates that the S-I stage containers have been overfilled to approximately 102%.

Depressing the adjust level drain pushbutton on the RP-1 control panel initiates the operation. Discharge Valve A516 opens. Fuel tanking computer A506 opens Pneumatic Controller A559 and the pneumatic controller opens Adjust Level Regulator A522 (refer to 1.2.2. par 2). Fuel Fill and Drain Valve B111 opens.

Fuel flows from the S-I stage containers (figure 3) through Fuel Fill and Drain Valve B111 and Couplings B112 and A4500 into the transfer line (figure 2). The fuel flows through Strainer A512, Adjust Level Regulator A522, Strainer A575, past Liquid Level Sensor A553, through Manual Valve A590, and past Liquid Level Sensor A552 through Discharge Valve A516. Fuel Tanking Computer A506 monitors the adjust level operation, and commands Pneumatic Controller A559 to start closing Adjust Level Regulator A522 at 101% of the programmed fuel level. At 100% of the programmed fuel level the tanking computer commands Pneumatic Controller A559 to close Adjust Level Regulator A522. The 'line inert position' of line inert-reset switch allows a feedback signal from closed Adjust Level Regulator A522 to close Fuel Fill and Drain Valve B111. An 'adjust level completed' light on the RP-1 panel indicates completion of this portion of the adjust level operation. By selecting the 'reset' position of the line inert-reset switch, the adjust level drain sequence may be repeated as necessary.

The transfer line purge automatically begins when the line inert-reset switch is in the 'line-inert' position. Adjust Level Regulator A522, Booster Line Valve A519, Discharge Valve A516, Line Drain Valve A520, and Circulate and Drain Valve A518 open. Transfer Pump Motor A504 operates Fuel Transfer Pump A502. The transfer line is drained as described in 3.2.3.

When the timer starts, the mast purge sequence is initiated through the 'automatic' position of the mast purge switch on the RP-1 panel. Solenoid Valve A5600 opens and 750-psig GN_2 from the launcher manifold flows through Check Valve A4501, and purges the filling mast and transfer line.

When the three-minute timer expires, it terminates the adjust level operation by stopping the mast purge, Fuel Transfer Pump A502, and Motor A504, and by closing Booster Line Valve A519, Adjust Level Regulator A522, Discharge Valve A516, Line Drain Valve A520, and Circulate and Drain Valve A518.

3.5. Replenish

If the fuel tanking requirements are increased after the adjust level operation has been completed, the automatic fuel replenish operation is initiated to transfer additional fuel to the vehicle.

Manual Valves A523, A524, and A590 and Fuel Vent Valves B106 are open. The RP-1 control panel power switch is in the 'on' position and the function selector switch is in the 'operate' position. A fuel differential pressure, based upon the new propellant loading requirements, is dialed into the fuel tanking computer panel. The fuel tanking computer indicator panel indicates that the S-I fuel containers are less than 100% full (because the required fuel differential pressure head has been increased).

Depressing the 'replenish' pushbutton on the RP-1 control panel starts the replenish operation. Fast Fill Valve A517, Slow Fill Valve A521, Discharge Valve A516, and Fuel Fill and Drain Valve B111 open. Transfer Pump Motor A504 operates Fuel Transfer Pump A502. The transfer pump motor start command also starts a 30-second timer.

Fuel flows by gravity from Storage Tank A501 through Manual Valve A523 to Fuel Transfer Pump A502. The pump discharges fuel at 2000 gpm through Strainer A511, Fast Fill Valve A517 and Slow Fill Valve A521, Orifices A550 and A551, Discharge Valve A516, and Manual Valve A590 to Liquid Level Sensor A553.

During the 30-second timer operation, the transfer line is filled at the fast fill rate of 2000 gpm because little time usually remains between the replenish operation and vehicle launch. Actual replenishing of the vehicle is accomplished at the slow fill rate of 200 gpm. When the 30-second timer expires, it closes Fast Fill Valve A517, causing fuel to flow through Slow Fill Valve A529 and Orifice A551. The orifice reduces the flow rate to 200 gpm and increases pump discharge pressure to approximately 185 psig. If Liquid Level Sensor A553 detects the presence of fuel before the 30-second timer expires, the sensor closes Fast Fill Valve A517.

Fuel flow continues through Strainer A575, Check Valve A580, Strainer A512, and enters the vehicle through Couplings A4500 and B112. Fuel flows through Fuel Fill and Drain Valve B111 into the sump of Fuel Container F-1. The lower interconnecting manifold distributes the fuel evenly to all the fuel containers.

The fuel tanking computer monitors the replenish operation, terminates the operation when the containers are 100% full, and then initiates the transfer line drain sequence. Slow Fill Valve A521, Booster Line Valve A519, and Fuel Fill and Drain Valve B111 close. Circulate and Drain Valve A518 and Line Drain Valve A520 open. The fuel transfer line is drained as described in 3.2.3. At the end of three minutes, the timer stops Fuel Transfer Pump A502 and Motor A504, and closes Discharge Valve A516, Line Drain Valve A520, and Circulate and Drain Valve A518.

4. DRAIN

In the event of a launch cancellation, the fuel is drained from the S-I stage fuel containers back into the storage facility tank. An automatic drain operation (a gravity drain and a transfer line drain sequence) is initiated from the RP-1 control panel in the fuel control center.

Manual Valves A523 and A524 and Fuel Vent Valves B106 are open. The RP-1 control panel power switch is in the 'on' position and the function selector switch is in the 'operate' position. Depressing the 'drain' pushbutton initiates the drain operation. Circulate and Drain Valve A518, Discharge Valve A516, Booster Line Valve A519, Adjust Level Regulator A522, and Fuel Fill and Drain Valve B111 open. Fuel from Containers F-1, F-2, F-3 and F-4 flows through Fuel Fill and Drain Valve B111 and Couplings B112 and A4500 into the fuel mast and transfer line. Fuel flows through Strainer A512, Booster Line Valve A519 and Adjust Level Regulator A522, and Strainer A575; past Liquid Level Sensor A553; through Manual Valve A590; and past Liquid Level Sensor A552 to Discharge Valve A516. From the discharge valve fuel flows past Shock Arrestor A515 and through Check Valve A534, Circulate and Drain Valve A518,

and Manual Valve A524 into Storage Tank A501. The gravity drain sequence flow rate gradually decreases from approximately 900 gpm to approximately 400 gpm because the head pressure decreases as the fuel drains out of the fuel containers.

When the vehicle containers are less than 10% full, Fuel Tanking Computer A506 opens Line Drain Valve A520 and starts Transfer Pump Motor A504, which drives Fuel Transfer Pump A502. The fuel transfer line is drained as described in 3.2.3.

Vacuum Breaker A4505 admits air into the fuel transfer line to prevent vacuum conditions as fuel drains from the line. At the end of three minutes, the timer stops the transfer Pump Motor A504 and Fuel Transfer Pump A502 and closes Fuel Fill and Drain Valve B111, Adjust Level Regulator A522, Booster Line Valve A519, Discharge Valve A516, Line Drain Valve A520, and Circulate and Drain Valve A518.

5. FUEL CONTAINER PRESSURIZATION

The fuel containers are pressurized at T -150 seconds to meet the fuel pump inlet requirements and to increase the structural integrity of the containers during flight. Fuel container pressurization Spheres B253 (figure 3) receive 3000-psig GN₂ from valve panel 9 (described in Volume V) and supply GN₂ for fuel container pressurization. GN₂ flows through Filters B254; Solenoid Valves B255, which open to admit GN₂ to the fuel containers on signal from Pressure Switch B107; and Orifices B256, which prevent pressure surge damage to fuel containers and associated lines. Pressure Switch B107 controls the fuel container pressurization by closing Solenoid Valves B255 when the container pressure increases to 17 ± 0.3 psig and by opening the valves when the container pressure decreases 0.5 to 2.0 psig. (Manual 3-way Valve B108 provides preflight switch calibration and is capped for flight.) Fuel Vent Valve B106 and Relief Valves B105 provide overpressure protection for the fuel containers and pressurization manifold by venting excess pressure at 19 ± 0.5 and 23 ± 1 psig, respectively.

6. FLIGHT

The fuel containers are pressurized by high-pressure GN₂ Spheres B253 through the same path as described in the preceding paragraph during the initial portion of S-I stage powered flight. Because constant container pressure is required during the initial portion of flight, Solenoid Valves B255 are initially controlled by Pressure Switch B107. As pressure requirements are reduced, the three solenoid valves are closed at set intervals by the flight sequencer. One closes at 30 seconds, another at 54 seconds, and the third at 70 seconds after liftoff; container pressurization and vehicle acceleration are then sufficient to meet fuel inlet and container structural requirements for the remainder of the powered flight.

During engine operation, fuel flows from each tank into two suction lines through Prevalves B103 to the inlet side of the engine fuel pumps. When the RP-1 level in Containers F-2 and F-4 drops below Level Sensors B104, a signal (described in Volume X) starts the guidance computer time base that initiates inboard engine cutoff. Most of the remaining fuel is utilized by the outboard engines during the interval (approximately 6 seconds) between inboard engine shutoff and outboard engine shutoff. Each engine consumes approximately 225 pounds of fuel per second at rated thrust. After a normal flight (approximately 147 seconds), approximately 4680 pounds of fuel remains in the containers and lines.

In the event of individual engine failure during flight, Conax Valve B2 signals Solenoid Control Valve B217 to close Prevalve B103, thereby shutting off fuel flow to the dead engine. The fuel transfer assembly then distributes dead-engine fuel to the other engines. An engine failure causes a fuel level differential of approximately five inches between the dead-engine container and the other containers, resulting in approximately ten gallons (68 pounds) additional residual fuel after engine cutoff.

LIST OF FINDING NUMBERS

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A501	1	Tank, RP-1 Storage	57,000 gallons	Buffalo Tank Co.	10429073	
A502	1	Pump, Transfer	2000 gpm	Byron Jackson, Div. of Borg Warner	Part of 10429100	
A503	1	Pump, Filter-Separator	600 gpm	Goulds Pump, Inc. 3755 4 x 6 - 116	Part of 10429127	
A504	1	Motor, Transfer Pump	250 hp	Westinghouse Electric	Part of 10429100	52B1
A505	1	Motor, Filter-Separator Pump	15 hp	Westinghouse Electric	Part of 10429127	52B2
A506	1	Computer, Fuel Tanking				54A8A3
A507	1	Computer, Fuel Density				54A8A4
A508						
A509	1	Filter-Separator	6 in., 600 gpm	Bowser, Inc. PN 842DR-600CL-FC-4	10429126	
A510						
A511	1	Strainer, Basket	8 in., 2000 gpm, 100 mesh	Zurn Industries, Inc.	10429110	
A512	1	Strainer, In-line	6 in., 2000 gpm, 100 mesh		10429009	

*

* Location: A = Ground; B = S-I Stage; E = S-IV Stage; G = Instrument Unit; H = Payload.

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A513						
A514	1	Jet Eductor	4 in. x 3 in. x 4 in., 200 gpm	Model S-4809 Penberthy Manufacturing Co.	10429108	
A515	1	Shock Arrestor	3 in., 1000 cu. in. capacity, 600 cu. in. displacement	Cherry-Burrell Corp. Model 14	10429109	
A516	1	Valve, Pneumatic	Discharge, 6 in., N.C., 750 psig	Hydromatics, Inc. Model A231S5	10429102	52A14
A517	1	Valve, Pneumatic	Fast Fill, 6 in., N.C., 750 psig	Hydromatics, Inc. Model A231S5	10429102	52A17
A518	1	Valve, Pneumatic	Circulate and Drain, 6 in., N.C., 750 psig	Hydromatics, Inc. Model A231S5	10429102	52A16
A519	1	Valve, Pneumatic	Booster Line Valve, 6 in., N.C., 750 psig	Hydromatics, Inc. Model A231S5	10429102	53A9A2
A520	1	Valve, Pneumatic	Line Drain, 4 in., N.C., 750 psig	Hydromatics, Inc. Model A231P4	10429103	52A11
A521	1	Valve, Pneumatic	Slow Fill, 4 in., N.C., 750 psig	Hydromatics, Inc. Model A231P4	10429103	52A18
A522	1	Regulator, Flow Control	2 in., N.C., 25 psig control pressure, 3-15 psig signal press.	The Annin Co. Model No. 1660	10429098	53A9A3
A523	1	Valve, Manual	10 in.	Wm. Powell Co. Fig. No. 1401-G	10429093	
A524	1	Valve, Manual	6 in.	Wm. Powell Co. Fig. No. 1401-G	10429095	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A525	1	Valve, Manual	6 in.	Wm. Powell Co. Fig. No. 1401-G	10429095	
A526	1	Valve, Manual	4 in.	Stockham PN G612	10429096	
A527	1	Valve, Manual	4 in.	Stockham PN G612	10429096	
A528	1	Valve, Manual	4 in.	Stockham PN G612	10429096	
A529	1	Valve, Manual	4 in.	Stockham PN G612	10429096	
A530						
A531						
A532	1	Valve, Manual	1 in., Drain	Wm. Powell Co. Dwg. No. D-18704-1 PN 1974	10429004	
A533	1	Valve, Manual	3/4 in., Drain	Wm. Powell Co. Dwg. No. D-18762-3/4 PN 1974	10429005	
A534	1	Valve, Check	6 in.	Wm. Powell Co. Dwg. No. 026198	B10429112	
A535	1	Valve, Check	4 in.	Wm. Powell Co. Dwg. No. 026198	B10429120	
A536	1	Valve, Check	4 in.	Wm. Powell Co. Dwg. No. 026198	10429120	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A537	1	Valve, Vent & Vacuum	3 in., Relieves at 4 oz. pressure and 1 oz. vacuum	Jordon Corp. Mod. No. 95-U	10429073	
A538	1	Regulator, Flow Control	6 in. 200 - 800 gpm 600 gpm - normal capacity Fuel Discharge	Bowser, Inc. PN 46879	Part of 10429126	
A539	1	Valve, Automatic Air Release		Bowser, Inc. PN 94245AR	Part of 10429126	
A540	1	Valve, Relief	6 in., Relieves at 2 1/2 psig	Jordon Corp. Model No. 209	10429073	
A541	1	Cover, Quick Opening	6 in.	Jordon Corp. PN 268	Part of 10429073	
A542	1	Valve, Relief	3/4 in., Approx. Setting 200 psig	Republic Mfg. Co. PN 648XB-4-12T	10429119	
A543	1	Valve, Relief	3/4 in., Approx. Setting 200 psig	Republic Mfg. Co. PN 648XB-4-12T	10429119	
A544	1	Valve, Relief	3/4 in., Approx. Setting 60 psig	Republic Mfg. Co. PN 648XB-3-12T	10429099	
A545	1	Valve, Relief	3/4 in., Approx. Setting 60 psig	Republic Mfg. Co. PN 648XB-3-12T	10429099	
A546	1	Valve, Relief	3/4 in., Approx. Setting 60 psig	Republic Mfg. Co. PN 648XB-3-12T	10429099	
A547	1	Valve, Relief		Bowser, Inc. PN 47841	Part of 10429126	
A548	1	Regulator, Automatic Water Drain	3/4 in.	Bowser, Inc. PN 47843	Part of 10429126	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A549	1	Valve, Manual	1 1/2 in., Drain	Bowser, Inc. PN 02M96	Part of 10429126	
A550	1	Orifice	6 in., Restrict to 2000 gpm 3.52 in., Orifice Diameter		10429070	
A551	1	Orifice	4 in., Restrict to 200 gpm, 0.8458 in. Orifice Diameter		10429071	
A552	1	Sensor, Liquid Level	1-1/4 in., NPT	Minneapolis-Honeywell Model No. AM-52-D5	10429121	52A4
A553	1	Sensor, Liquid Level	1-1/4 in., NPT	Minneapolis-Honeywell Model No. AM-52-D5	10429121	53A9A5
A554	1	Manhole	10 in. Min. Filler I.D., with Fuel Filler Cover		Part of 10429073	
A555	1	Manhole	With Ladder & Cover		Part of 10429073	
A556	1	Well, Sampling			Part of 10429073	
A557	1	Vent, Automatic Air	Air Eliminator 4 in., N.O.	Valve & Primer PN 149C	10429117	
A558	1	Vent, Air	4 in., Vent Trap Reservoir		10429006	
A559	1	Controller, Pneumatic	Electrically operated, 3 psi output @ 1 ma input, 15 psi output @ 5 ma input			53A9A4
A560	1	Gage, Liquid Level	Measures in Following Increments: Empty, 1/4, 1/2, 3/4, Full	Crosby Ashton	Part of 10429073	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A561	1	Gage, Temperature	+ 20°F to + 140°F Range, 6 in. Dial	Taylor X61K6125	Part of 10429073	
A562	1	Gage, Pressure Compound	1/4 in., NPT, 30 psig, 30 in. Mercury Suction		10429123	
A563	1	Gage, Pressure	1/4 in., NPT, 0-300 psig, 4-1/2 in. Dial		10429122	
A564	1	Gage, Pressure	1/4 in., NPT, 0-300 psig, 4-1/2 in. Dial		10429122	
A565	1	Gage, Differential Pressure		Bowser, Inc. PN 00M67	Part of 10429126	
A566	1	Switch, Pressure	Actuates @ 39 \pm 4 psig Increasing Pressure	Meletron Corp. Model No. 320-1-527	10429113	52A5
A567						
A568	1	Adapter, Inlet	3 in., Coupling-Half	Ever-Tite		
A569	1	Adapter, Inlet	3 in., Coupling-Half			
A570	1	Adapter, Inlet	3 in., Coupling-Half			
A571	1	Valve, Relief	3/4 in., Approx. Setting 60 psi	Republic Mfg. Co. PN 648XB-3-12T	10429099	
A572	1	Valve, Manual	1/4 in.	Wm. Powell Co. Dwg. No. D-18730-1/4	10429005	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A573	1	Valve, Manual	1/4 in.	Wm. Powell Co. Dwg. No. D-18730-1/4	10429005	
A574	1	Valve, Manual	1/4 in.	Wm. Powell Co. Dwg. No. D-18730-1/4	10429005	
A575	1	Strainer	8 in., Reverse Flow, 2000 gpm, 100 Mesh	Zurn Industries Inc.	10429111	
A576	1	Vacuum Breaker	3/8 in., N.C.	Parker Aircraft Co. PN F509	10429004	
A577	1	Vacuum Breaker	3/8 in., N.C.	Parker Aircraft Co. PN F509	10429004	
A578	1	Switch, Temperature	Normal Actuation at 107.5° \pm 2.5°F	Fenwal, Inc. Model No. 80016-4	10429092	52A10
A579	1	Switch, Temperature	Normal Actuation at 107.5° \pm 2.5°F	Fenwal, Inc. Model No. 80016-4	10429118	52A12
A580	1	Valve, Check	3 in., 125 psig	Valve and Primer Corp. Model No. 603	10429068	
A581 through A589		are not functionally applicable to this system.				
A590	1	Valve, Manual	8 in., Gate	Wm. Powell Co. Dwg. No. 027211	10429067	
A591						
A592						

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A593	1	Valve, Relief	3/4 in., Approx. Setting, 60 psig	Republic Mfg. Co. PN 648XB-3-12T(60 psi)	10429099	
A594 through A601		are not functionally applicable to this system.				
A602	1	Valve, Relief	Relieves at 5 psig	Republic Mfg. Co. PN 488-1655-1	10429001	
A603 through A607		are not functionally applicable to this system.				
A608	1	Gage, Sight	Indicates Liquid Level	Bowser, Inc. P/N 47B19	Part of 10429126	
A609	1	Valve, Float		Bowser, Inc. P/N 02M13	Part of 10429126	
A610	1	Valve, Manual	1/2 in.	Bowser, Inc. PN 02M94	Part of 10429126	
A611	1	Valve, Manual	1/4 in.	Bowser, Inc. PN 16401	Part of 10429126	
A612	1	Valve, Manual	1/4 in.	Bowser, Inc. PN 16401	Part of 10429126	
A613	1	Valve, Manual	1/2 in., Drain	Bowser, Inc. PN 02M94	Part of 10429126	
A614	1	Valve, Manual	3/4 in., Drain	Bowser, Inc. PN 02M95	Part of 10429126	
A615	1	Valve, Manual	3/4 in.	Bowser, Inc. PN 92A99	Part of 10429126	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A616	1	Valve, Relief	1/2 in., Cracking Pressure 95 +5 psig	Republic Mfg. Co. PN 625B-4-8-T		
A617 through A2849 are not functionally applicable to this system.						
A2850	1	Valve, Manual	1/4 in., Vent	Futurecraft Corp. PN 30205	10437647	
A2851	1	Gage, Pressure	3500 psig - Normal Reading, 0-10000 psig, Range	U.S. Gauge Co. Model No. 5003	10437648	
A2852	1	Valve, Manual	5/16 in.	Robbins Aviation PN SSNA-375A-6T	10437684	
A2853	1	Valve, Manual	1/4 in., Vent	Futurecraft Corp. PN 30205	10437647	
A2854	1	Regulator, Manual	3500 psig to 750 psig	Grove Valve & Regulator Co., Model No. 94 X PN M-12954-A	10437651	
A2855	1	Valve, Relief	Relieves at 900 +50 psig, Reseats at 750 psig min.	Republic Mfg. Co. PN 625B-9-6	10437652	
A2856	1	Gage, Pressure	750 psig - Normal Reading, 0-1500 psig Range	U.S. Gauge Co. Model No. 5003	10437688	
A2857	1	Valve, Manual	1/4 in., 750 psig, Vent	Futurecraft Corp. PN 30205	10437647	
A2858	1	Valve, Manual	5/16 in., 750 psig	Robbins Aviation PN SSNA-375A-6T	10437684	
A2859	1	Valve, Manual	1/4 in., 750 psig, Vent	Futurecraft Corp. PN 30205	10437647	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A2860	1	Filter	3000 psig Supply, 10 Micron Nominal	Permanent Filter Corp. PN 10813	10437650	
A2861	1	Orifice	0.015 Orifice Dia.	Made From 10437706 or AN929-6C	10436539	
A2862	1	Snubber, Pressure	70 c.c. per min. Nominal Flow at 45 psid	Chemiquip Co. PN AC14	10341147	
A2863	1	Valve, Solenoid	3-way, 2-position, N.O.	Marotta Valve Corp. PN 202873-113	10437618	52A6A11
A2864	1	Valve, Solenoid	3-way, 2-position, N.O.	Marotta Valve Corp. PN 202873-113	10437618	52A6A9
A2865	1	Valve, Solenoid	3-way, 2-position, N.O.	Marotta Valve Corp. PN 202873-113	10437618	52A6A7
A2866	1	Valve, Solenoid	3-way, 2-position, N.O.	Marotta Valve Corp. PN 202873-113	10437618	52A6A5
A2867	1	Valve, Solenoid	3-way, 2-position, N.O.	Marotta Valve Corp. PN 202873-113	10437618	52A6A3
A2868	1	Valve, Solenoid	3-way, 2-position, N.C.	Marotta Valve Corp. PN 202873-113	10437618	52A6A12
A2869	1	Valve, Solenoid	3-way, 2-position, N.C.	Marotta Valve Corp. PN 202873-113	10437618	52A6A10
A2870	1	Valve, Solenoid	3-way, 2-position, N.C.	Marotta Valve Corp. PN 202873-113	10437618	52A6A8
A2871	1	Valve, Solenoid	3-way, 2-position, N.C.	Marotta Valve Corp. PN 202873-113	10437618	52A6A6

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A2872	1	Valve, Solenoid	3-way, 2-position, N.C.	Marotta Valve Corp. PN 202873-113	10437618	52A6A4
A2873 through A2880 are not functionally applicable to this system.						
A2881	1	Valve, Manual	1/8 in.	Hoke, Inc., Series 280 PN 4PY281	10437696	
A2882	1	Switch, Pressure	Actuates at 750 \pm 50 psig On Rising Pressure	Barksdale Valves PN B1X-A32SS	10437754	52A7
A2883	1	Switch, Pressure	Actuates at 1500 \pm 200 psig On Rising Pressure	Barksdale Valves PN B1X-X65SS	10437753	52A8
A2884 through A2889 are not functionally applicable to this system.						
A2890	1	Valve, Manual	3/8 in. 3000-5000 psig	Robbins Aviation PN SSNG-375A-6T	10428551	
A2891						
A2892						
A2893						
A2894	1	Orifice	1/32 in. Orifice Dia.	Made from AN 820-4C	10428611	
A2895	1	Orifice	1/32 in. Orifice Dia.	Made from AN 820-4C	10428611	

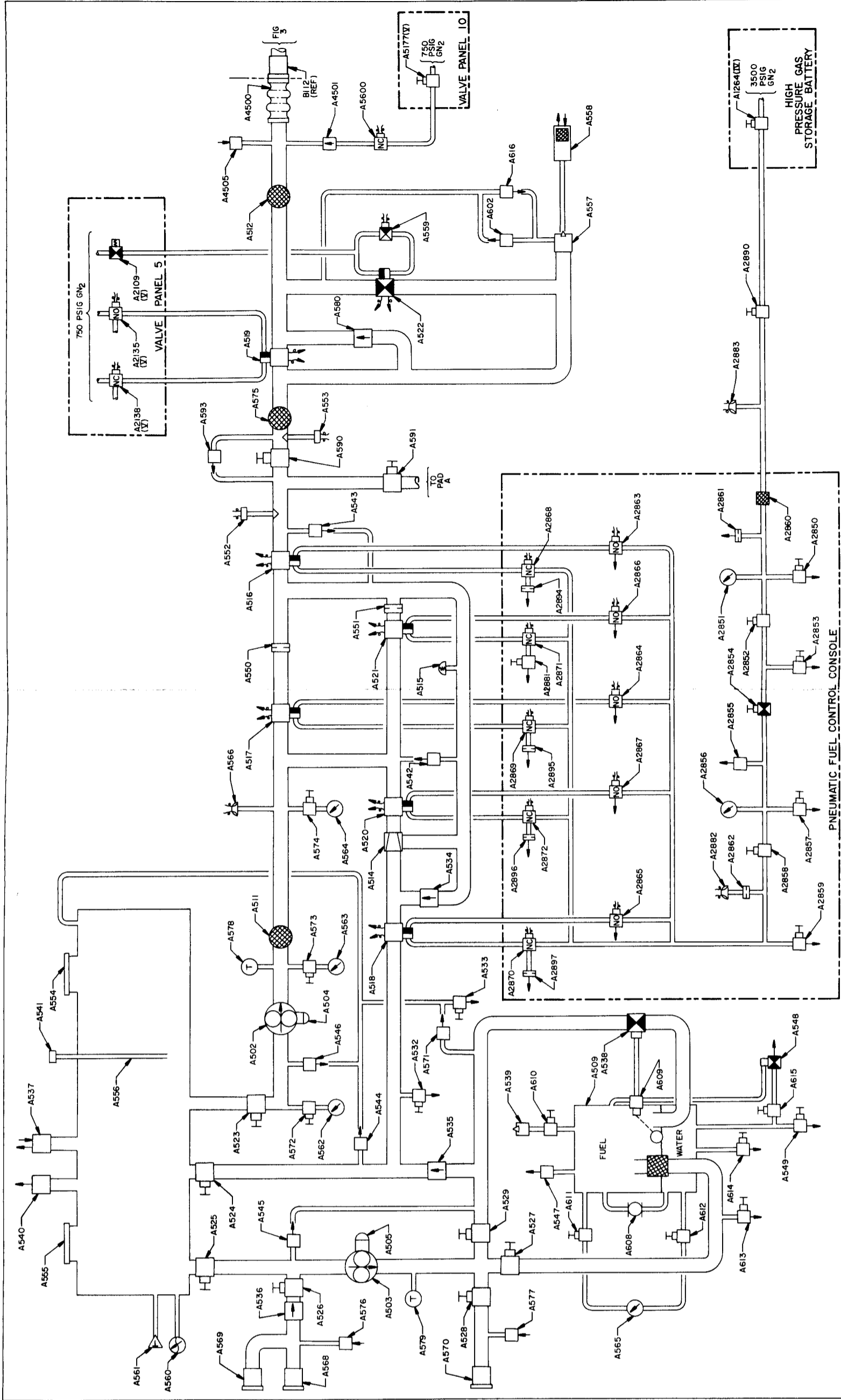
FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A2896	1	Orifice	1/32 in. Orifice Dia.	Made from AN 820-4C	10428611	
A2897	1	Orifice	1/32 in. Orifice Dia.	Made from AN 820-4C	10428611	
A2898 through A4499 are not functionally applicable to this system.						
A4500	1	Coupling-Half, Flexible		Flexonics PN 107435	10426984	
A4501	1	Valve, Check	Cracking Pressure 0.5 - 1.0 psig	James, Pond & Clark, PN 239T-4TT	10426502	
A4502						
A4503						
A4504						
A4505	1	Vacuum Breaker	3/4 in., N.C.	O.P.W. Corp. PN 476L-3/4	10425830	
A4506 through A5057 are not functionally applicable to this system.						
A5058	1	Valve, Solenoid	3-way, 2-position, N.O. Density Computer Isolation	Marotta Valve Corp. PN 223194	75M02986-1	57A9A10
A5059 through A5065 are not functionally applicable to this system.						

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A5066	1	Valve, Solenoid	3-way, 2-position, N.O. Density and Tanking Computer Isolation	Marotta Valve Corp. PN 223194	75M02986-1	57A9A11
A5067						
A5068						
A5069						
A5070	1	Valve, Solenoid	3-way, 2-position, N.O. Tanking Computer Isolation	Marotta Valve Corp. PN 223194	75M02986-1	57A9A9
A5071 through A5599 are not functionally applicable to this system.						
A5600	1	Valve, Solenoid	N.C., Fuel Mast Purge	Marotta Valve Corp. PN 212783-1	10437739	53A60
A5601 through B100 are not functionally applicable to this system.						
B101	1	Coupling-Half, Quick Disconnect	1/4 in., Fuel Fill and Drain Valve, Control Pressure	E.B. Wiggins Oil Tool Co., Inc. PN 6105A4B4	20M30136	
B102						
B103-1	1	Valve, Pneumatic	N.C., Fuel Prevalve	Parker Aircraft Co. PN F61C0018	20M30043	9A26
B103-2	1	Valve, Pneumatic	N.C., Fuel Prevalve	Parker Aircraft Co. PN F61C0018	20M30043	9A29

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
B103-3	1	Valve, Pneumatic	N.C., Fuel Prevalve	Parker Aircraft Co. PN F61C0018	20M30043	9A32
B103-4	1	Valve, Pneumatic	N.C., Fuel Prevalve	Parker Aircraft Co. PN F61C0018	20M30043	9A35
B103-5	1	Valve, Pneumatic	N.C., Fuel Prevalve	Parker Aircraft Co. PN F61C0018	20M30043	9A38
B103-6	1	Valve, Pneumatic	N.C., Fuel Prevalve	Parker Aircraft Co. PN F61C0018	20M30043	9A41
B103-7	1	Valve, Pneumatic	N.C., Fuel Prevalve	Parker Aircraft Co. PN F61C0018	20M30043	9A44
B103-8	1	Valve, Pneumatic	N.C., Fuel Prevalve	Parker Aircraft Co. PN F61C0018	20M30043	9A47
B104						
B105	2	Valve, Relief	Relieves at 23 \pm 0.5 psig		20M30020	
B106-1	1	Valve, Pneumatic	Vent and Relief, Relieves at 19 \pm 0.5 psig		20M30000	11A45
B106-2	1	Valve, Pneumatic	Vent and Relief, Relieves at 19 \pm 0.5 psig		20M30000	11A46
B107	1	Switch, Pressure	Actuates at 17 \pm 0.3 psig	Frebank Co. PN 4188-1	20M30184	11A50
B108	1	Valve, Manual	3-way, Calibration Valve	Benton Corp. PN B-15600	10414087	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
B109	1	Switch, Pressure	Fuel Overfill Actuators at 18.84 \pm .09 psig	Servomechanisms, Inc. PN 816106	20M30154	9A24
B110	1	Valve, Manual	3-way, Calibration Valve	Benton Corp. PN B-15600	10414087	
B111	1	Valve, Pneumatic	750 psig, N.C., Fuel Fill and Drain	Parker Aircraft Co. PN F61C0018	20M30043	9A23
B112	1	Coupling-Half, Quick Disconnect	Fuel Fill and Drain		20M30203	
B113						
B114	1	Coupling-Half, Quick Disconnect	1/4 in., Fuel Density Computer	E.B. Wiggins Oil Tool Co., Inc. PN 6005R79A4	20M30139	
B115	1	Coupling-Half, Quick Disconnect	1/4 in., Fuel Tanking Computer	E.B. Wiggins Oil Tool Co., Inc. PN 6005R79A4	20M30139	
B116	1	Coupling-Half, Quick Disconnect	1/4 in., Fuel Density Computer	E.B. Wiggins Oil Tool Co., Inc. PN 6005R79A4	20M30139	
B117	1	Coupling-Half, Quick Disconnect	3/8 in., Fuel Vent Valves Control Pressure	E.B. Wiggins Oil Tool Co., Inc. PN 6105R105A6	20M30391	
B118 through B253		are not functionally applicable to this system.				
B254	3	Filter	3/4 in.	Permanent Filter Corp. PN 20030	20M30129	
B255-1	1	Valve, Solenoid	N.C., Fuel Pressurization	Marotta Valve Corp. PN 219664-1	20M30171	11A47

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
B255-2	1	Valve, Solenoid	N.C., Fuel Pressurization	Marotta Valve Corp. PN 219664-1	20M30171	11A48
B255-3	1	Valve, Solenoid	N.C., Fuel Pressurization	Marotta Valve Corp. PN 219664-1	20M30171	11A49
B256	3	Orifice	0.2374 \pm .001 in. dia.	Parker Aircraft	20M30197	
B257 through B369			are not functionally applicable to this system.			
B370	1	Coupling-Half	1/4 in., Fuel Bubbling	E.B. Wiggins Oil Tool Co., Inc. PN 6005R79A4	20M30139	
B371	8	Valve, Check	1/4 in., Fuel Bubbling	James, Pond & Clark, Inc. PN P279T-4BB(L) Type I	20M30125	
B372	8	Orifice Assy.	0.018 \pm .002 in. dia. Fuel Bubbling		20M30198	
B373	1	Filter, Assy.	20-micron, Fuel Bubbling	Cosmic-Fairchild PN 30599	20M30428	
B374 and subsequent finding numbers			are not functionally applicable to this system.			



NOTE: WHEN A ROMAN NUMERAL FOLLOWS A FIND NUMBER [A541(I)], THE COMPONENT IS COVERED IN THAT VOLUME OF THIS DOCUMENT. SEE VOLUME XI FOR EXPLANATION OF SYMBOLS.

FIGURE 2. COMPLEX 37 RP-1 FUEL SYSTEM

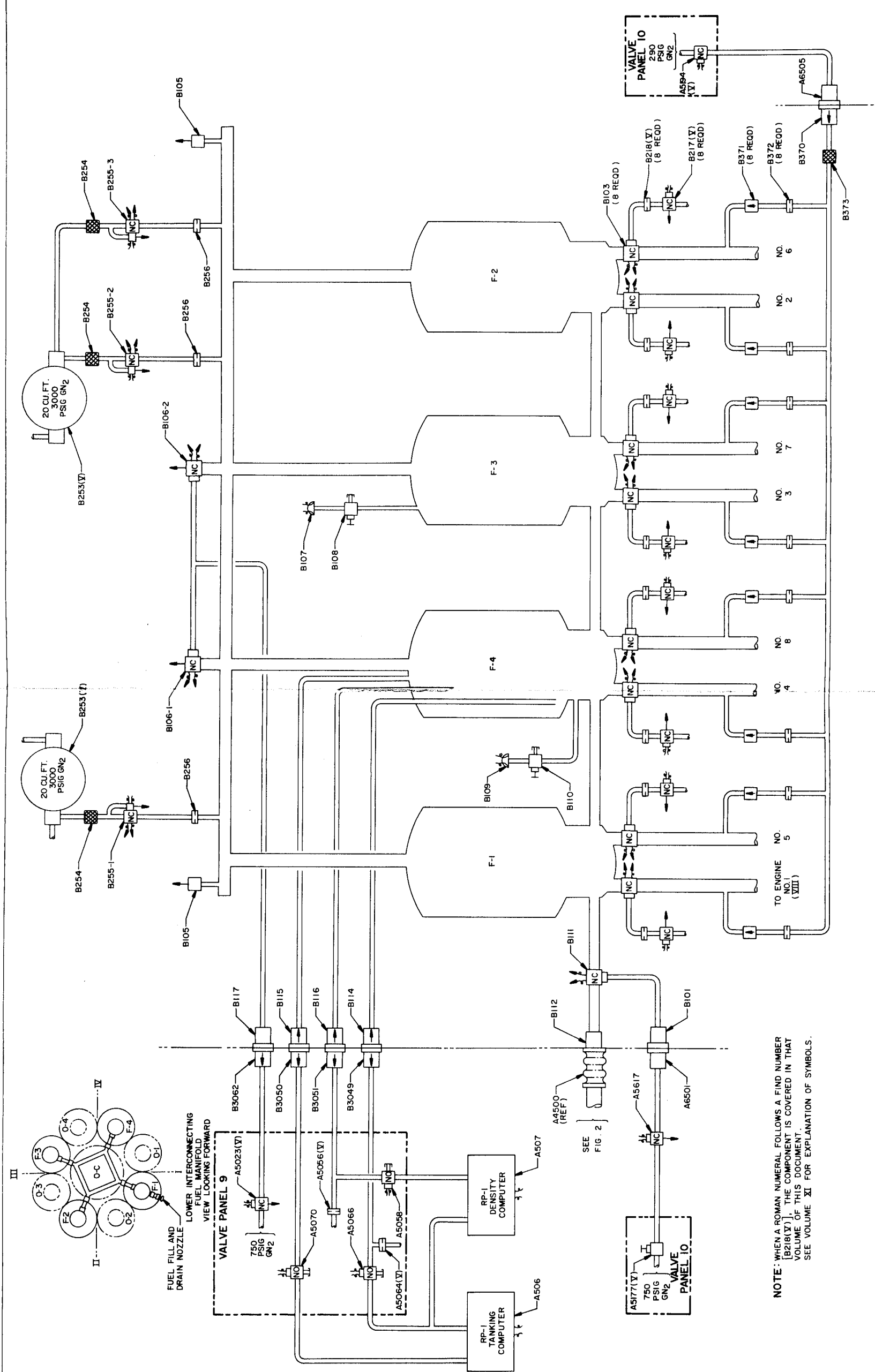


FIGURE 3. VEHICLE RP-1 FUEL SYSTEM

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CCSD-NO (Dept. 2240), SIMMONS, F. (2)	KN-VG22, DOWLING, C. (4)
DAC (Dept. A2-857), BELWOOD, H.	KN-VG23, ROUSE, C. (4)
DAC, KEATING, J.	KN-VL, GREENE, D. (5)
DAC, HOLLISTER, R. (Dept. A3-770)	KN-VL, WHISENANT, E. (2)
I-I/IB-SI, CHAMBERS, J.	KN-VM, PICKETT, A.
I-I/IB-SIV, FERGUSON, W.	KN-VM2, ROBINSON, G.
I-I/IB-SIVH, LEAGUE, R.	KN-VM2, RAINWATER, W.
I-I/IB-SIVL/DAC, STOOPS, G.	KN-VM3, PANTOLIANO, T. (3)
I-I/IB-SIVL-NASA/DAC-SACTO, TYSON, O.	KN-VM22, DeLaROSA, H.
I-I/IB-SIVL-NASA/DAC-SANTA MONICA, WEAVER, E.	KN-VM22, FANNIN, L. (8)
I-MICH-OA, STEVENSON, H.	KN-VM23, SCOVILLE, D.
I-MICH-OA, QUINTON, H.	KN-VM24, HILL, L.
KN-BS27, WHISENANT, R.	LVO-DIR, WILLIAMS, M.
KN-DA, POPPEL, T.	LVO-AD, ZEILER, A.
KN-DE2, HAHN, R.	LVO-L, BELLAMY, E. (5)
KN-DE2, GRIFFIN, F.	R-ASTR-E, FICHTNER, H.
KN-DE2, DZIADON, E. (2)	R-ASTR-EA, SMITH, R. (5)
KN-DE2, REID, R.	R-ASTR-EAA, PASCHAL, L.
KN-DE2, MOORE, R.	R-ASTR-ES, ADEN, R. (3)
KN-DE2, STAHLEY, S.	R-ASTR-ESI, MILNER, R.
KN-DE2, CHAPPLE, E.	R-ASTR-I, HOBERG, O.
KN-DE4, DOWNS, J.	R-ASTR-IM, POWELL, J.
KN-DE5, GRIFFIN, F.	R-ASTR-TR, WAGNON, W.
KN-DF2, CAREY, T.	R-ME-A, NOWAK, M.
KN-DL2, BUCHANAN, D.	R-P&VE-AV, NEIGHBORS, W.
KN-DP2, MIMS, W.	R-P&VE/DAC, MEZO, C.
KN-DP2, MINTON, C.	R-P&VE-PA, REED, K.
KN-DP2, SPARKMAN, O.	R-P&VE-PEM, HOLMES, J. (2)
KN-DP2, WASILESKI, C.	R-P&VE-PM, FUHRMANN, H. (2)
KN-DP4, NELSON, R.	R-P&VE-PP, HEUSINGER, B.
KN-DP5, WRIGHT, R.	R-P&VE-PT, WOOD, C.
KN-DR2, HOOKER, J. (5)	R-P&VE-V, PALAORO, H.
KN-DS232, BUNCH, M.	R-P&VE-VA, HOFFMAN, C.
KN-ET, BRIDEWELL, C.	R-P&VE-VAS, MOON, O.
KN-FE, DODD, R. (2)	R-P&VE-VF, ROTHE, K.
KN-AG, RUSSELL, L. (2)	R-P&VE-VI, FAULKNER, W. (2)
KN-GT44, HAWKINS, G.	R-P&VE-VK, BOONE, C.
KN-L, GORMAN, R.	R-P&VE-VM, BECK, M.
KN-LP2, SWEAT, C.	R-P&VE-VNW, DEVENISH, R. (5)
KN-M, PICKETT, A.	R-P&VE-VO, KISTLER, W. (20)
KN-P, PETRONE, R.	R-P&VE-VS, SCHULZE, W.
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